

WHAT IS CLAIMED IS:

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A solid state image pickup device comprising:

a plurality of photoelectric conversion elements for converting light into electric charges, said photoelectric conversion elements being uniformly disposed on a two-dimensional plane in vertical and horizontal directions;

a plurality of vertical charge transfer paths for transferring electric charges to a downstream side in the vertical direction, said vertical charge transfer path being disposed adjacent to vertically and uniformly disposed photoelectric conversion elements;

a read gate for reading electric charges from each photoelectric conversion element to said adjacent vertical charge transfer path;

vertical addition means for adding electric charges of two or more photoelectric conversion elements on said vertical charge transfer path, by controlling said read gates and said vertical charge transfer path to read electric charges from some of said plurality of photoelectric conversion elements to said vertical charge transfer path, transfer the read electric charges on said vertical charge transfer path to the downstream side in the vertical direction, and read electric charges from others of said plurality of photoelectric elements on the downstream side to said vertical charge transfer path;

a horizontal charge transfer path for transferring electric charges to a downstream side in the horizontal direction, said horizontal charge transfer path being disposed adjacent to one ends of said plurality of vertical charge transfer paths;

a transfer gate for transferring electric charges on said vertical charge transfer paths to said horizontal charge transfer path; and

horizontal addition means for adding electric charges transferred from two or more of said vertical charge transfer paths, on said horizontal charge transfer

path, by controlling said transfer gate and said horizontal charge transfer path to transfer electric charges from some of said plurality of vertical charge transfer paths to said horizontal charge transfer path, transfer the electric charges on said horizontal charge transfer path to the downstream side in the horizontal direction, and transfer  
5 electric charges from others of said plurality of vertical charge transfer paths on the downstream side to said horizontal charge transfer path.

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2. A solid state image pickup device according to claim 1, wherein said plurality of photoelectric conversion elements can convert light of each of a plurality of  
10 colors into electric charges and said vertical charge transfer path and said horizontal charge transfer path adds electric charges of a same color.

3. A solid state image pickup device according to claim 2, wherein:  
said plurality of photoelectric conversion elements uniformly disposed in  
15 the vertical direction can convert light of each of at least two colors into electric charges; and

said vertical addition means adds electric charges of a same color by controlling said read gate and said vertical charge transfer path to read electric charges from some of said plurality of photoelectric conversion elements uniformly  
20 disposed in the vertical direction to said vertical charge transfer path by a first read operation, thereafter transfer the read electric charges in the vertical direction to positions adjacent to others of said plurality of photoelectric conversion elements on the downstream side capable of converting light of the same color not read by the first read operation into electric charges, and read the electric charges from the others of  
25 said plurality of photoelectric conversion elements by a second read operation to add the read electric charges to the electric charges transferred to the positions.

4. A solid state image pickup device according to claim 3, wherein said photoelectric conversion elements from which the electric charges are read by the second read operation are spaced at least by one photoelectric conversion element in the vertical direction toward said horizontal charge transfer path, from said  
5 photoelectric conversion elements from which the electric charges are read by the first read operation.

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5. A solid state image pickup device according to claim 1, wherein said transfer gate includes a plurality of control gates extending in parallel in the horizontal  
10 direction, said plurality of control gates crossing said plurality of vertical charge transfer paths.

6. A solid state image pickup device according to claim 5, wherein said plurality of control gates include a control gate which covers areas different in the  
15 vertical direction of one and another of said plurality of vertical charge transfer paths.

7. A solid state image pickup device according to claim 5, wherein said plurality of control gates include a control gate which covers areas different in the vertical direction of one and another set of a plurality of vertical charge transfer paths  
20 adjacent in the horizontal direction.

8. A solid state image pickup device according to claim 5, wherein said control gates includes a plurality of first and second layer polysilicon electrodes formed above said vertical charge transfer paths.

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9. A solid state image pickup device according to claim 8, wherein said

plurality of second layer polysilicon electrodes include a second layer polysilicon electrode formed only above said first layer polysilicon electrode above some of said plurality of vertical charge transfer paths.

- 5 10. A solid state image pickup device according to claim 8, wherein said plurality of first layer polysilicon electrodes include a first layer polysilicon electrode having different lengths in the vertical direction above different ones of said plurality of vertical charge transfer paths.

- 10 11. A solid state image pickup device according to claim 1, wherein said vertical charge transfer path includes a first conductivity type semiconductor layer for transferring electric charges accumulated in said photoelectric conversion element, a first vertical charge transfer path having second conductivity type semiconductor layers in said first conductivity type semiconductor layer for forming a potential barrier in two regions different in the vertical direction, and a second vertical charge transfer path having a second conductivity type semiconductor layer in said first conductivity type semiconductor layer for forming a potential barrier in one of the two regions on a downstream side;

20 said transfer gate includes at least first to fourth control gates remoter in this order from said horizontal charge transfer path, said first to fourth control gates extending in the horizontal direction above said plurality of vertical charge transfer paths;

said first and third control gates are formed above said first conductivity type semiconductor layer; and

- 25 said second and fourth control electrodes cross said first and second vertical charge transfer paths in the two regions.

12. A solid state image pickup device according to claim 11, wherein said second and third control electrodes are connected in common.

13. A control method for a solid state image pickup device having a plurality  
5 of photoelectric conversion elements for converting light into electric charges, the photoelectric conversion elements being uniformly disposed on a two-dimensional plane in vertical and horizontal directions, a plurality of vertical charge transfer paths for transferring electric charges to a downstream side in the vertical direction, the vertical charge transfer path being disposed adjacent to vertically and uniformly  
10 disposed photoelectric conversion elements, a horizontal charge transfer path for transferring electric charges to a downstream side in the horizontal direction, the horizontal charge transfer path being disposed adjacent to one ends of the plurality of vertical charge transfer paths, the method comprising the steps of:

(a) reading electric charges from some of the plurality of photoelectric  
15 conversion elements to the vertical charge transfer path;

(b) transferring the electric charges on the vertical charge transfer path to a downstream side in the vertical direction;

(c) reading electric charges from others of the plurality of photoelectric conversion elements on the downstream side to the vertical charge transfer path and  
20 adding the read electric charges to the electric charges transferred to the downstream side;

(d) transferring electric charges from some of the plurality of vertical charge transfer paths to the horizontal charge transfer path;

(e) transferring the electric charges on the horizontal charge transfer  
25 path to a downstream side in the horizontal direction; and

(f) transferring electric charges from others of the plurality of vertical

charge transfer paths on the downstream side to the horizontal charge transfer path and adding electric charges from two or more vertical charge transfer paths on the horizontal charge transfer path.

- 5 14. A control method for a solid state image pickup device according to claim 13, wherein the plurality of photoelectric conversion elements can convert light of each of a plurality of colors into electric charges and said steps (c) and (f) adds electric charges of a same color.

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- 10 15. A control method for a solid state image pickup device according to claim 13, wherein:

the plurality of photoelectric conversion elements uniformly disposed in the vertical direction can convert light of each of at least two colors into electric charges;

- 15 said step (b) transfers the read electric charges in the vertical direction to positions adjacent to others of the plurality of photoelectric conversion elements on the downstream side capable of converting light of the same color not read by said step (a) into electric charges; and

- 20 said step (c) reads the electric charges from the others of the plurality of photoelectric conversion elements on the downstream side to add the read electric charges to the electric charges transferred to the positions.

16. A control method for a solid state image pickup device according to claim 13, wherein:

- 25 said step (d) transfers added electric charges of a same color from some of the plurality of vertical charge transfer paths to the horizontal charge transfer

said step (f) transfers electric charges of the same color from others of the plurality of vertical charge transfer paths on the downstream side to the horizontal charge transfer path and adding the electric charges of the same color transferred from two or more vertical charge transfer paths.

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